

NASA SBIR/STTR Technologies

S1.09-9462 - Miniature Optical Isolator



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Identification and Significance of Innovation

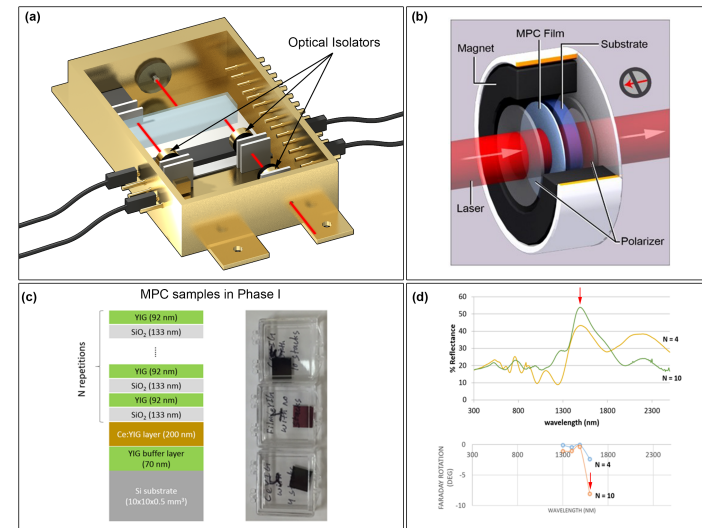
Optical feedback due to back reflections can damage or disrupt the operation of a laser system, especially when operating at high power. Optical isolators are passive, unidirectional devices that reduce the optical feedback using the Faraday effect. Since high-power or frequency-stabilized laser sources are commonly used in optical communication and metrology, optical isolators can be found in various applications. Laboratory demonstrations already have shown that cold-atom systems are superior to any other technologies for navigation and timing applications. However, the biggest hurdle in transitioning this technology into field-deployable units is quite often the sheer volume and weight of the system. To take full advantage of the extraordinary performance of cold atom systems, miniaturization of individual components is necessary. One of the topics of interest to NASA is the development of miniature optical isolators for 780 nm, fully packaged in $<0.5 \text{ cm}^3$, offering $>40 \text{ dB}$ isolation and $<2 \text{ dB}$ forward loss.

Estimated TRL at beginning and end of contract: (Begin: 3 End: 7)

Technical Objectives and Work Plan

Technical Objectives: **Objective 1.** Refinement of the Phase II MOI design. **Objective 2.** Fabrication of Phase II prototype Faraday rotators for the target wavelength. **Objective 3.** Testing, optimization, and assembly of the MOI prototypes. **Objective 4.** Validation of the MOI device performance. **Objective 5.** Integration of the MOI device in a cold atom prototype system. **Objective 6.** Establishment of the commercial viability of the MOI device.

Work Plan: **Task 1.** Analyze and Optimize the Phase II MOI Platform Concept; **Task 2.** Fabricate and Characterize MPC Samples; **Task 3.** Assemble Test Setup for All Target Wavelengths and Perform Tests; **Task 4.** Analyze Test Results and Iterate Design; **Task 5.** Fabricate Phase II Prototype Faraday Rotators; **Task 6.** Standardize and Document the Fabrication Procedure for MPC Films; **Task 7.** Package MOI Device; **Task 8.** Test MOI Device Performance in Various Environments; **Task 9.** Install and Test MOI Device in Cold Atom Environments; **Task 10.** Explore Commercial Potential and Product Viability; **Task 11.** Define Manufacturing Technology for Commercial Production; **Task 12.** Manage Program and Submit Reports



NASA Applications

The proposed MOI can be used immediately in atomic clocks used in various NASA missions. The MOI technology not only replaces current miniature isolators and performs better, it can also be used in the wavelength range in which no current technology allows miniaturization of optical isolators. MOI devices will also be used in next-generation inertial navigation systems based on cold-atom systems, and in other NASA systems that require optical isolation, such as remote gas sensing and magnetometer applications.

Non-NASA Applications

As an essential component in cold-atom-based metrology and in an inertial measurement unit, the proposed MOI device can be used in timing applications and in inertial navigation in submarines, missiles, satellites, and airplanes.

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NON-PROPRIETARY DATA